Guide 35

Energy Efficiency in Offices – Small Power Loads

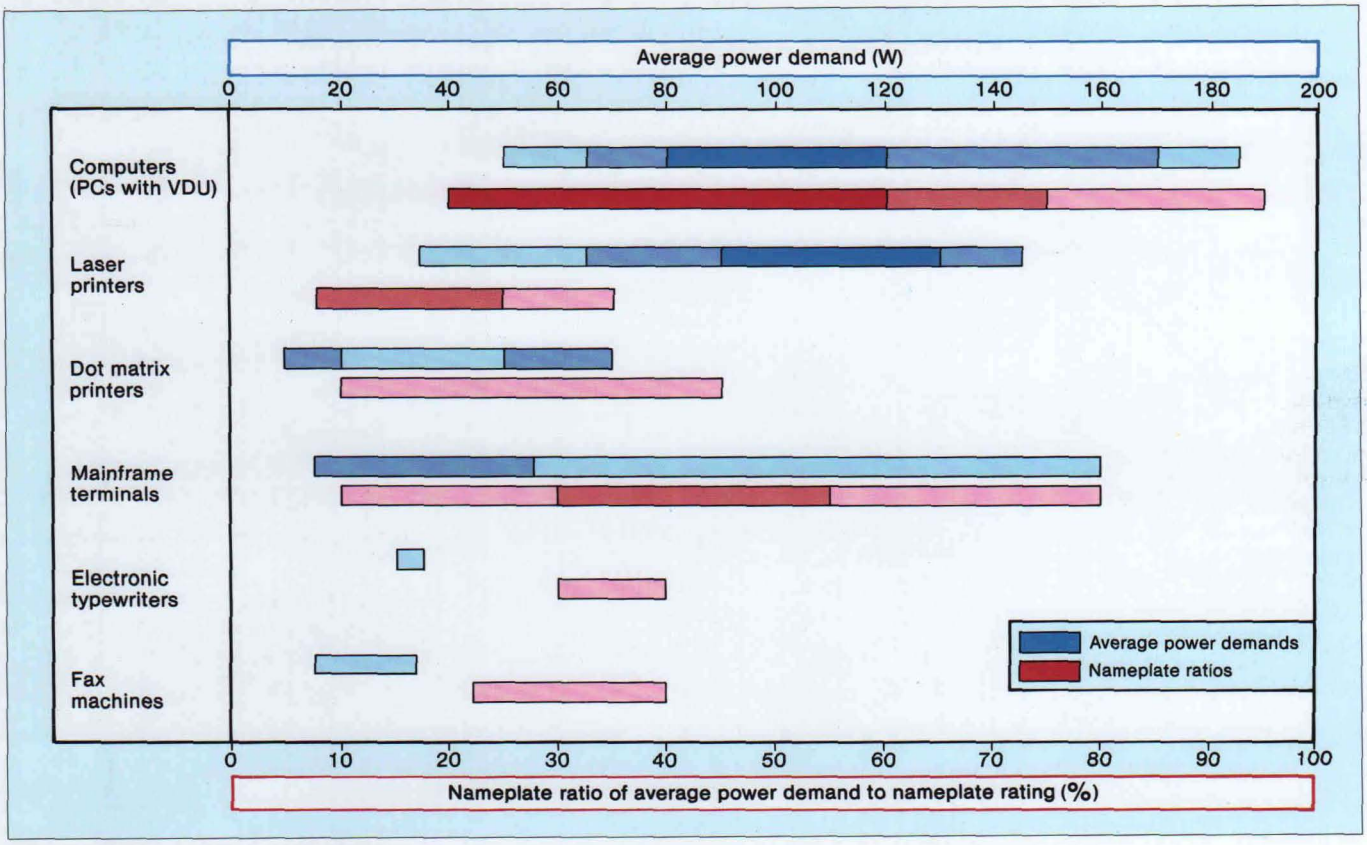

Figure 1. Equipment power demands

Introduction

This Guide is designed to further understanding of the power demands of office equipment.

Surveys were carried out to understand how equipment is used in offices and to indicate future trends. The data in this guide has been derived from measurements of existing office and equipment loads.

The data will assist building services engineers to produce efficient, cost-effective electrical and air-conditioning design solutions. It will also allow managers to plan their future energy use and understand the benefits to be gained from specifying efficient equipment. The Guide's contents will help designers avoid over specification or unnecessary specification of either mechanical cooling or air-conditioning.

Constant Load Equipment

Power demands for various items of equipment were measured over periods of at least one working day of normal use. Figure 1 indicates the range of average power demands obtained for specific units and compares the actual power consumption to the manufacturers' nameplate ratings.

Although some instantaneous demands varied, the loads were almost constant over a period of time. Across most manufacturers' ranges of personal computers (PCs), there was a trend for computing and electrical power demand to be in proportion, but there were exceptions. Specifiers should select their equipment carefully to avoid models which consume unnecessarily high levels of energy and thus can reduce costs.

Figure 1 can be used to provide a realistic estimate of equipment power demands. Most units are in the areas of heaviest shading.

"A clear understanding of small power loads can lead to energy efficient, cost-effective electrical and air-conditioning design solutions."

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

Variable Load Equipment

The average power demands for machines such as hot drinks vending machines and photocopiers are closely related to the amount of work done by them.

Most vending machines only have a small standing load with nominal local heat gain. This power demand is generally proportional to the number of drinks sold. Most of the energy used to produce the drinks is dispersed throughout the building. Figure 2 shows typical average power demands relative to the number of hot drinks supplied per 8 hour working day. Different lengths of working day can be allowed for pro rata. Vending machines should be chosen to avoid those with higher standing loads, particularly since such loads continue for 24 hours per day.

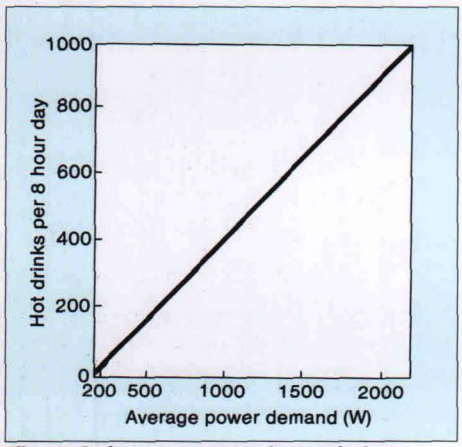

Figure 2. Average power demands for vending machines

The power demand of photocopiers increases with the number of prints produced. For the 12 machines monitored, it was found that the power demand whilst printing was approximately 80% of the nameplate rating, and whilst idling was approximately 20%.

Usage patterns for photocopiers were studied for periods of up to 8 working days during which office machines were typically printing for 10% of the time. Unusual loads such as large reports could cause the time spent printing to increase to as much as 40% with 80% possible in print rooms. Based on this, figure 3 indicates average power demand values.

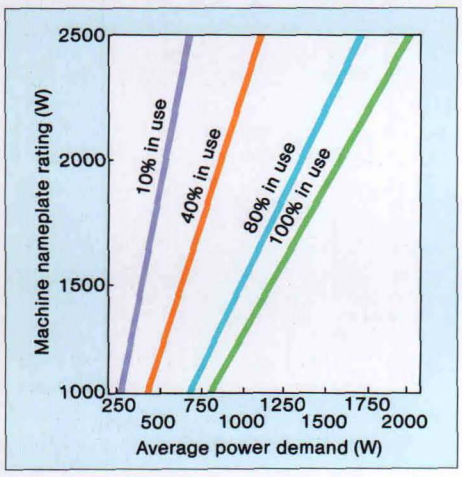

Figure 3. Average power demands for photocopiers

Photo: Office equipment in use

Usage Diversity

Despite the increasing penetration of Information Technology (IT) equipment into offices, we have not yet reached a saturation level where everybody in an office uses a computer.

The need for computers depends on the individual's job function. A typist is likely to be an intensive user of computers, printers and photocopiers, whereas company managers and directors may only use them occasionally.

Using the findings of a questionnaire survey of 74 companies, with a combined workforce of over 3500 people, it was possible to identify the degree of computer usage amongst different types of employee.

The results of this analysis are shown in table 1.

The average percentage of computer operating time and average power demand can be assessed by:

- using table 1,
- assessing the estimated percentage of operating time for intermittent users, and
- making due allowance for the lengths of time that staff are out of the office.

	Continuous users %	Intermittent users %	Non-users %
Managers	45	45	10
Typists	100	0	0
Clerks	52	33	15
Engineers	57	32	11
Draughtsmen	40	47	13
Surveyors	23	51	26
Salespersons	75	12	13
Accountants	78	7	15
Insurance staff	75	25	0
Computer analysts	85	15	0

Table 1. Computer usage amongst different job categories

However, the number of computers in operation in each user group will usually vary from hour to hour and from day to day. For example, if each computer, in a group of 100, were in operation for 20% of the time on average, a probability calculation shows that up to 30% of them may be in use simultaneously. To determine the likely maximum power demand, a usage diversity factor has to be applied to the average percentages to determine the likely maximum number of computers in use at any one time.

Usage diversity factors for groups of computers are shown in figure 4.

Lower power demand figures may be used where organisations, operate energy efficiency policies of manual or part automatic switching off and maintain staff awareness of the potential for savings.

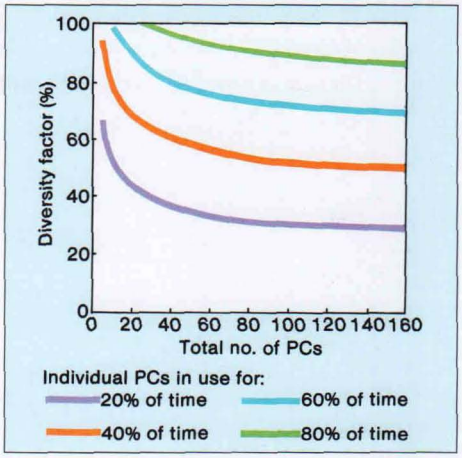

Figure 4. Usage diversity factors for groups of PCs

Shared Machines

Machines such as laser printers, photocopiers and fax machines are usually shared between a number of users. Table 2 indicates the minimum likely staff numbers per machine for larger offices.

	Persons per machine
PCs	1
Laser printers	3
Photocopiers	20
Fax machines	20
Modems	20

Table 2. Minimum staff numbers per machine

Occupation Densities

Our survey indicated that whilst occupation densities varied from 5 m^2 per person to 30 m^2 per person the majority were in the range 8–16 m^2 per person.

Property developers typically specify occupation densities of between 8 and 10 m^2 of net usable office area per person. However, the actual value will ultimately depend on the nature of the work done in the office. High density offices might be those used for activities such as financial services and telesales where desk and movement space is minimal. Low density offices might be those requiring desk space for bulky equipment such as drawing offices, or those where there is a need for increased access and other communal areas.

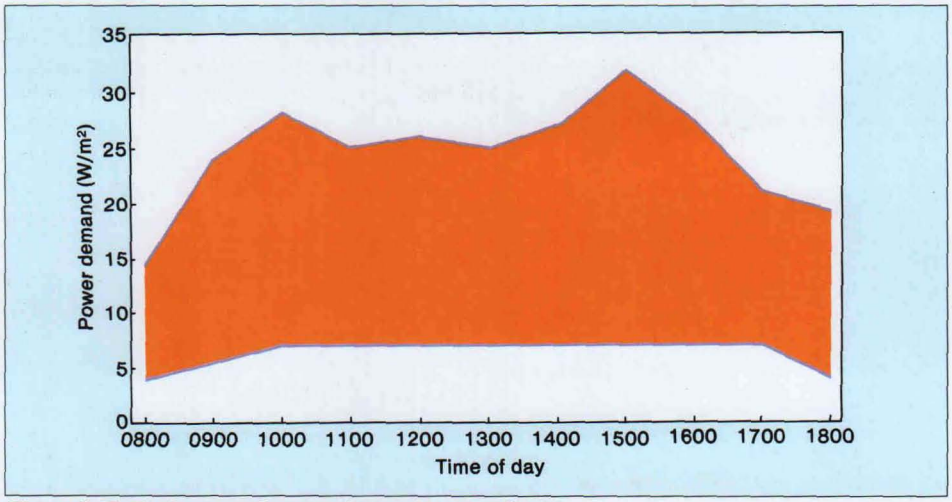

Figure 5. Typical range of power demands per unit area

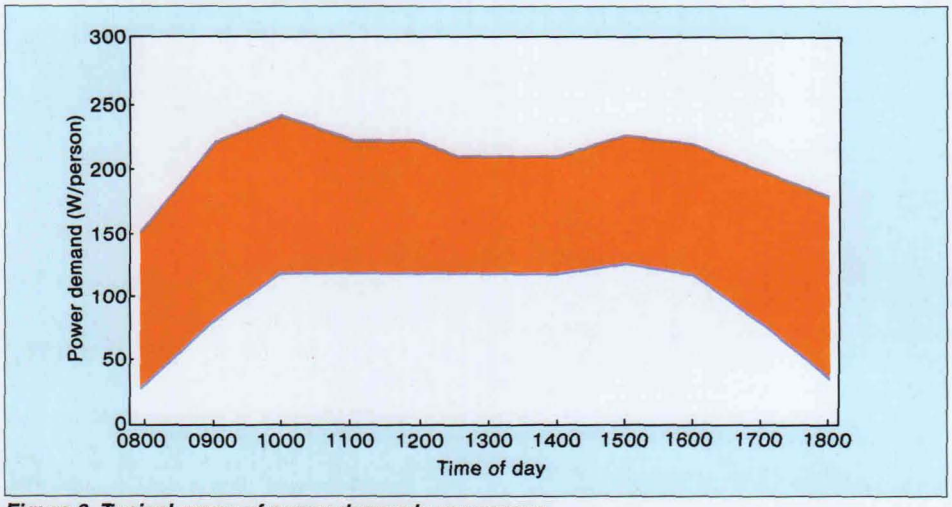

Figure 6. Typical range of power demands per person

Typical Average Loads

Average demands over half hour periods were monitored for ten different offices for at least five working days of normal use. The maximum and minimum limits obtained are shown in figures 5 and 6. Loads varied between 7 W/m² and 32 W/m² and were fairly uniform across the day.

High power demands per unit floor area were closely related to occupation density. The site which peaked at 32 W/m² had a floor space allocation of only 8 m² per person, significantly less than the other buildings.

If the highest consumption machines are chosen from figure 1 and the worst case numbers sharing are assumed from table 2, then for self-contained offices of around 50 persons, calculations show that the load could in theory reach 280 W/person. This figure should be considered in design although in practice the range of values in figures 5 and 6 are the most likely.

Localised "hot spots" where the heat gain is much higher than the average power demand across the floor need to be identified.

For example, offices with a staff of less than 10 people will still require access to photocopiers, printers and fax machines as well as their own computer terminals. Allowing for the inclusion of all these facilities in the same area, the resulting power demand could quite feasibly lie between 300 and 400 W/person. It is therefore important that such areas are identified and allowed for in the design.

Figure 7 indicates worst case power demands per person for offices of different overall staff numbers. The values are based on worst case individual machine loads and worst case numbers of persons sharing.

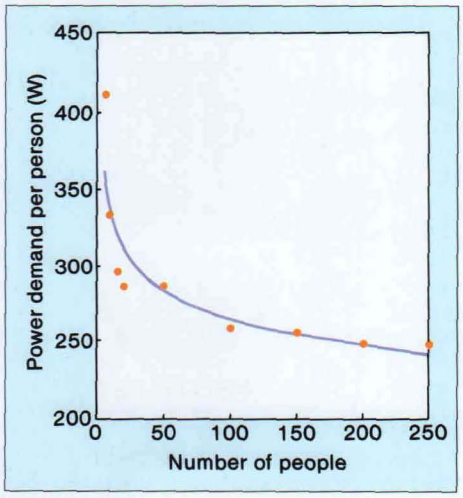

Figure 7. Power demands per person for self-contained offices

Example Calculation

A 1000 m² office area is to house a market sales force of 100 people. The company has standardised on equipment with nameplate ratings of 200 W for PCs, 850 W for laser printers, 1250 W for photocopiers, 85 W for fax machines and 20 W for modems and there is to be one drinks vending machine.

Heat gain calculation

From figure 1 estimate the worst case nameplate ratios and calculate the average demands:

PCs	0.8 x 200	= 160 W
Laser printers	0.3 x 850	= 255 W
Fax machines	0.4 x 85	= 34 W

Assumptions

Photocopiers are for general office use. Figure 3 shows that the average demand is 325 W. Three hot drinks are dispersed per person per day. Figure 2 shows that the average demand through the day is 650 W. The nameplate ratio for modems is 1, so the average demand is 20 W.

From table 1, if 87% of sales persons use PCs, there are at most 0.87 x 100 = 87 PCs. Based on many sales staff being absent from the office for long periods and assuming 40% usage of each PC, figure 4 shows that the overall usage diversity factor is 55%. The effective number of PCs in use is thus 0.55 x 87 = 48 PCs.

Similar diversity applies to laser printers in larger offices. Based on this and table 2, there are at most 16 laser printers – one for each three PCs in use, 5 photocopiers, 5 fax machines and 5 modems.

Total demand

PCs	48 x 160	=	7 680 W
Laser printers	16 x 255	=	4 080 W
Fax machines	5 x 34	=	170 W
Modems	5 x 20	=	100 W
Photocopiers	5 x 325	=	1 625 W
Hot drinks			650 W
Total			14 305 W

The average loads are therefore 14 W/m² or 143 W/person – values which are in line with those shown in figures 5 and 6. Figure 7 shows that the W/person estimate is less than the worst case demand for an office of 100 people. Local hot spot areas may need a higher value.

If the client anticipates replacing machines and specifies no requirement to increase use, PC demands could increase by 50 W per machine in the immediate future. This would increase demand to 17 W/m² or 167 W/person.

A Guide to Calculations

Estimates for the maximum likely office power demands can be guided by the steps indicated in figure 8. Average likely power demands can be found if the step allowing for the usage diversity factors for computers from figure 4 is ignored.

Energy managers will usually have information about the future office functions and the numbers and types of equipment. Nameplate power ratings can be multiplied by average nameplate ratios estimated from figure 1 to obtain average power demands for individual equipment. Usage diversity allowances can be applied to computers based on those indicated in table 1 and figure 4 to obtain likely maximum power demands.

If the office is a speculative new development, design engineers will have little information on which to base estimates. In these situations, a worst case estimate for equipment power demands and numbers of machines can be made based on figure 1 and table 2. Further additions may be appropriate to allow for "hot spot" areas and future trends. It is unlikely that all of the worst cases will occur simultaneously and designers should allow for this. However, future changes of building use need to be considered.

Further Reading

BSRIA Technical Note 8/92 – Small power loads

MJ DeLaHunt, BR Associates Inc. Trends in electricity consumption due to computers and miscellaneous equipment in office buildings. ACEEE, 1990

H Michaels, J DaSilva, Xenergy Inc, W Gould, Consolidated Edison. Electronic equipment load growth. ACEEE, 1990

J Leary, S Herridge. General power in offices: the implications for HVAC design. Electricity Council

Butler Cox Report. Information Technology and buildings. 1987

C Parsloe, M Hejab. Power demands due to portable office equipment. BSRIA Report No 63310/1, 1992

J Harris, J Roturier, Les Norford & Ari Rabi. Electronic office equipment: the impact of market trends on end-user demand for electricity. 1989

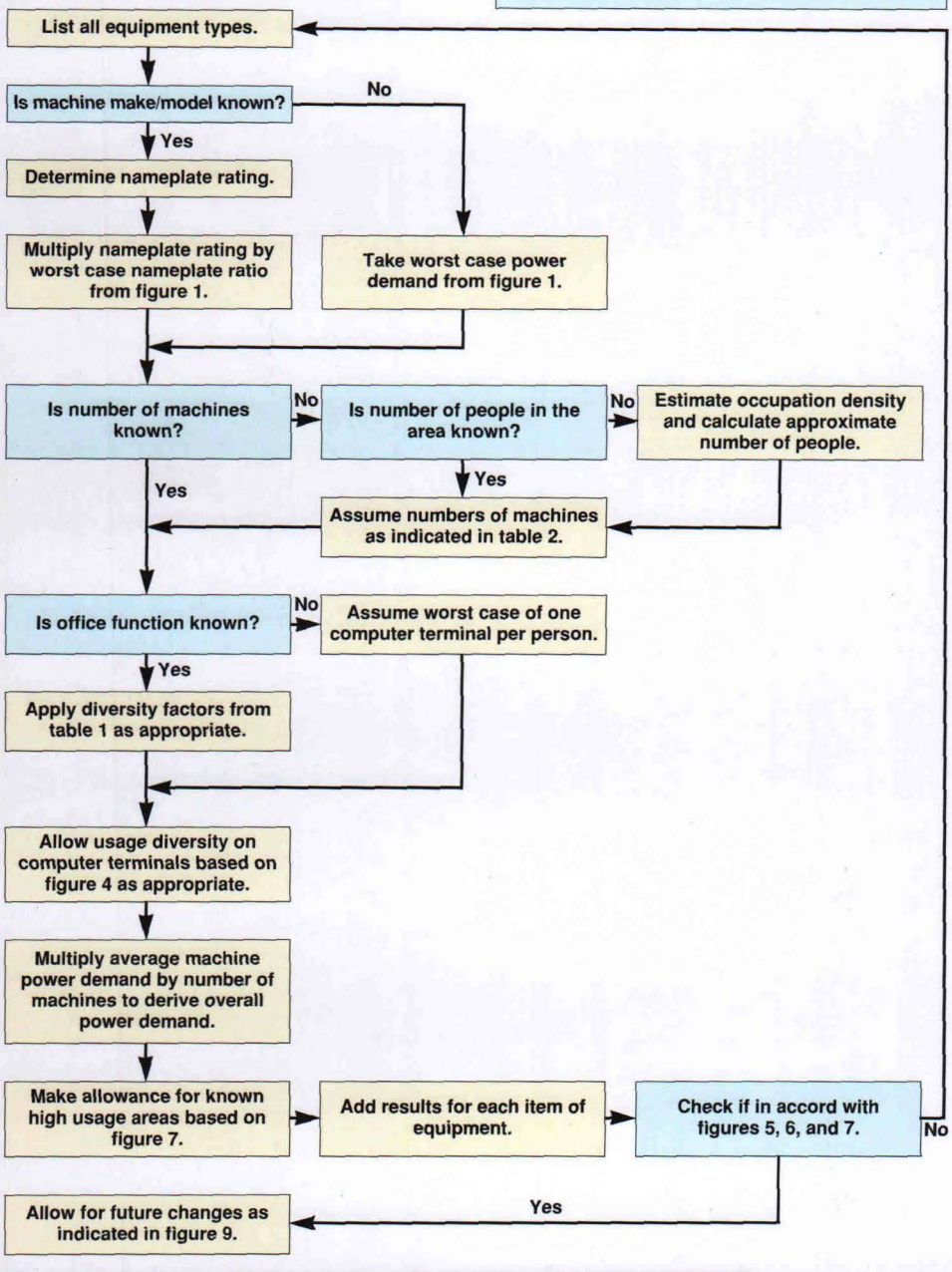

Figure 8. Decision guide for estimation of maximum likely power demands

Future Trends

A number of trends in equipment development and usage can be identified.

Office heat gains will change under two opposing influences. Firstly, there is likely to be further uptake of equipment as more uses are developed and more powerful machines become available. Secondly, balanced against this is the likelihood that the energy consumption of machines will decrease as technology advances.

A summary of forecast trends for the next ten years is as follows.

Up to the year 2000

- More computers in offices, rising to one machine per desk but not exceeding this level.
- Larger computer screens consuming up to 50 W more.
- More intensive usage of machines ie fewer machines switched off at any time.
- More fax machines – rising to say one per five people.

After the year 2000

- Low-energy flat computer screens.
- Low-energy printers.
- More modems, possibly up to one per person.
- Energy saving features such as automatic switching to idle mode.

The future trends shown in figure 9 indicate how the worst case power demand is likely to change for a typical office area containing 50 people.

The analysis shows that power requirements in the short term may actually increase – largely due to the introduction of more and larger computer screens but in the long term will decrease – largely due to the introduction of low-energy machines.

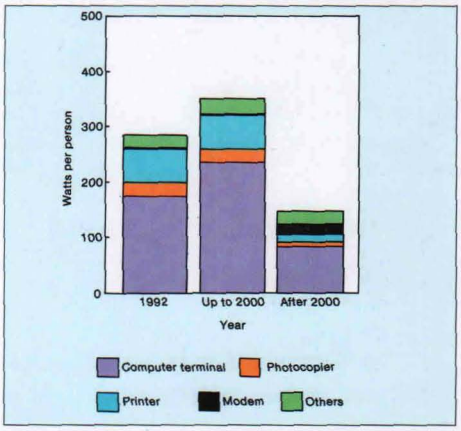

Figure 9. Future power demand per person

This Energy Consumption Guide has been produced in close association between BRECSU, and BSRIA, the Building Services Research and Information Association.

The cooperation of the owners, designers, managers and occupants of the buildings used in the Guide is gratefully acknowledged.

For further copies of this or other Best Practice programme publications please contact BRECSU and ETSU.

Printed in the UK for HMSO. Dd. 8439907, 6/95, C30, 38938

For buildings-related projects: Enquiries Bureau, BRECSU, Building Research Establishment, Garston, Watford, WD2 7JR. Tel 01923 664258. Fax 01923 664787. E-mail brecsuenq@bre.co.uk

For industrial projects: Energy Efficiency Enquiries Bureau, ETSU, Harwell, Oxfordshire OX11 0RA. Tel 01235 436747. Telex 83135. Fax 01235 433066.